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Orality spreading in Pirahã

ABSTRACT: In this paper we discuss orality and nasality in some Brazilian Indian languages. Based mainly in data from Pirahã we question the universality of the raised position of the velum in the neutral position as proposed in Chomsky & Halle (1968), and propose that languages can be typologically distinguished by the number of obstruents in their inventories: those that have a great number of obstruents exhibit nasalization processes, whereas those that have a great number of sonorants, as is the case of Pirahã, exhibit oralization processes.
KEYWORDS: Nasalization; Oralization; Neutral position; Phonological systems.

RESUMO: Neste trabalho, discutimos oralidade e nasalidade em algumas línguas indígenas brasileiras. Tomando por base dados principalmente do pirahã, questionamos o caráter universal da posição elevada do véu palatino, conforme proposto por Chomsky & Halle (1968), para a posição neutra de articulação. Propomos que as línguas podem ser tipologicamente diferenciadas pelo número de obstruintes que têm em seus inventários: aquelas com um número grande de obstruintes exibem processos de nasalização, enquanto outras, como o pirahã, com um grande número de sonorantes exibem processos de oralização.
PALAVRAS-CHAVE: Nasalização; Oralização; Posição neutra de articulação; Sistemas fonológicos.

1. INTRODUCTION

Chomsky & Halle (1968:300) defined a neutral position of the velum for speech articulation. According to them, the neutral position of the velum is raised; that is, the position of orality. We claim that facts of some Brazilian Indian languages, especially from Pirahã, sustain that this aspect of the neutral position is subject to parametrization. We will argue that languages may set the neutral position of the velum. In some languages, the neutral articulation of the velum is lowered; that is, segments are articulated as nasal unless otherwise specified.

This discussion has implications for a theory of feature specification. It is widely claimed that [nasal] is privative. It is also widely claimed that there are no languages that require segments to be phonologically specified as [-nasal] (Steriade 1995). In other words, if one assumes that the unmarked value for [nasal] is [-nasal], this means that, in the unmarked case, underlying representations may contain only [+nasal] specifications. The value [-nasal] is assigned by the default rule to any segment that does not otherwise receive a [nasal] specification in phonology.

The second claim only makes sense if one assumes that the neutral position of articulation of the velum is universally defined as raised (Steriade 1993, 1995). However, if there are languages whose neutral position of the velum is lowered, the feature [-nasal] becomes a necessity in underlying representations. Moreover, it predicts that long distance orality harmony may exist. In this paper we analyze data from Pirahã and we propose that some facts are straightforwardly analyzed as orality spreading if we assume that in this language the neutral position of the velum is lowered.

Pirahã is a Brazilian Indian language of the Mura family spoken along the Maici River, an affluent of Madeira River, Amazon. Curt Nimuendajú was probably the first to write about the Pirahãs in the 20's, but only in the 60's their language started to be described. Some of the linguistic studies on Pirahã are Sheldon (1974), Everett (1983, 1988), Sandalo (1987, 1989). This paper uses the data of Sandalo (1989) and of fieldwork material collected by Sandalo in 1991.

2. NASALITY AND ORALITY IN PIRAHÃ

Pirahã has one of the smallest phonemic inventories in the world (Everett 2003):[1]

2.1. Consonants

p	t	k	ʔ
b		g	
	s		h

2.2. Vowels

i		
		o
	a	

[1] Everett (2003) claims that the phoneme /s/ is not found in female speech, but we have found it in our data and it is realized as a retroflex [ʂ] Pirahã is a tonal language.

The voiced stops /b/ and /g/ are replaced by nasal stops, [m] and [n] respectively, at the beginning of an utterance or after a hesitation pause (//). Inside the utterance domain a voiced stop is never nasalized even when it is surrounded by nasal vowels (see example 4). This phenomenon has been noticed by Heinrichs 1964, Everett 1983, and Sandalo 1989. The data below is from Sandalo (1989:38, 39):

1.	**mege kaobée**	'to fall on the floor'
2.	**kapeega bege kaobée**	'the notebook fell on the floor'
3.	**kapeega // mege kaobée**	'the notebook // fell on the floor'
4.	**pẽẽbõỹ**	'rain'

Although all the vowels and some of the consonants of Pirahã can be nasal phonetically, there are no intrinsically nasal vowels or consonants in this language (Everett 1983:208). In fluent speech nasality occurs across syllable, word, or even phrase boundaries, skipping consonants, as can be noted in the sentence below extracted from a narrative collected by Everett in 1988 and analyzed by Sandalo (1989:38):

5. **ʔigɪsãʔãỹ ʔãõ tãỹhõãỹ hĩ tãỹhõãỹ gẽ ʔãõãbããỹ**
take-neg foreigner pot 3 pot 2 stranger
ʔã tãỹhõãỹ ʔãõõẽbẽhĩ õỹ tãỹhõãỹ
to die pot foreinger short pot
'Do not take the pot from the foreigner, you can die by the short foreigner's pot'

Note, however, that in careful speech (e.g. words collected via elicitation) oral vowels must appear in sequences of phonemes where no glides (in the sense of Chomsky & Halle 1968, that is, w, y, h, ʔ) occur.[2] That is, in the context of obstruents exclusively.

6.	**kaáeé**	'house'
7.	**pee**	'water'
8.	**kose**	'eye'
9.	**kapeega**	'paper'
10.	**kaobée**	'to fall'
11.	**tagasága**	'knife'

[2] Some authors believe that to classify [h] and [ʔ] as glides is counterintuitive (cf. Ladefoged 1973). Halle (1995), however, claims that these elements cannot be classified as consonants if we understand [+consonantal] as "constriction in the central passage through the oral cavity". According to Kenstowicz (1994:453), this definition of [+consonantal] "is premised on the idea that the essential property of consonants is that they approximate a tube closed at both ends; ... this has the acoustic consequence that the lowest vowel resonance on the spectrogram descends to zero when next to a consonant. Only a constriction in the oral cavity is capable of achieving this approximation to a tube closed at both ends." This implies that pharyngeal and laryngeal segments will pattern as [-consonantal] glides."

3. GLIDES AND NASALIZATION

Everett (1983:208) observed that, even though there are no vowels that are intrinsically nasal, Pirahã vowels nasalize optionally in syllables that contain [h] and [ʔ].

Sandalo (1989: 36, 37) notes that vowels can be nasal in environments that contain [w] and [y], as well as [h] and [ʔ]. On the basis of such distribution, this author hypothesized that the phenomenon of nasality is associated with the class of glides in the sense of Chomsky & Halle 1968.

12. **peébõỹ** 'rain'
13. **kopãỹ** 'eye'
14. **ʔãpapãỹ** 'head'
15. **taỹhõãỹ** 'pot'
16. **ʔãwẽỹɦĩ** 'leg'
17. **ɦõẽẽ** 'bow'
18. **ʔãpãỹtãỹ** 'hair'

More specifically, Sandalo (1989) analyzes the Pirahã facts as a case of bi-directional nasal spreading triggered by the two classes of glides (in the sense of Chomsky & Halle 1968). According to this analysis, nasal spreading is blocked by [+consonantal] segments only in slow speech.

The association of laryngeal (class II) glides and nasality has been noticed by Matisoff (1975:267). This author, working with Lisu (Southeast Asia), says that "…the relationship between *h*-, vocalic onset, and nasalization was noted long ago by the missionary Fraser, 1922 (p.3-4)". Matisoff notes that nasality of vowels contiguous to [h] and [ʔ] occurs in many Southeast Asia languages (however, there is no evidence for nasality in the environment of [w] and [y] in these languages):

19. Thai: /**hɛ̀ɛ**/ [**hãã**] 'stop', /**ʔɔ̀ɔk ʔ**/ 'to go away, to leave'
20. Lahu: /**hɔ**/ [**hɔ**]~ [**hɔ̃**] 'elephant', /`**ɔ-ha**]~ [`**ɔ-hã**] 'spirit'

Matisoff, based on Ohala (1972), attempted to explain vowel nasality in the context of [**h**] and [ʔ] claiming that these sounds favor nasality because they are articulated lower than the velum, leaving it free to be in a relaxed (lowered) position.

The problem that we approach in this paper is more complex than the one discussed by Matisoff because it is the whole class of glides in the sense of Chomsky & Halle (w, y, h, ʔ) that favors nasality in Pirahã. Matisoff's hypothesis is inadequate to explain the phenomenon in Pirahã since it cannot explain the nasality of segments in the context of [y] and [w]. On the basis of the explanation he proposes for the association of nasality and glides, one would be forced to say that all vowels can cause nasalization since all vowels are articulated below the velum. Such generalization is obviously wrong.

4. NASALITY AS A NEUTRAL POSITION OF ARTICULATION

Chomsky and Halle (1968:300) defined a neutral position for speech production. According to them:

> "In most x-ray motion pictures of speech, it can readily be observed that just prior to speaking the subject positions his vocal tract in a certain characteristic manner. We shall call this configuration the "neutral position" and shall describe some of the ways in which it differs from the configuration of the vocal tract during quiet breathing. In the latter stage the velum is lowered, thereby allowing air to pass through the nose; in the neutral position, on the other hand, the velum is raised, and the air flow thorough the nose is shut off. The body of the tongue, which in quiet breathing lies in the relaxed state on the floor of the mouth, is raised in the neutral position to about the level that it occupies in the articulation of the English vowel [e] in the word 'bed', but the blade of the tongue remains in about the same position as in quiet breathing."

Steriade (1993, 1995) argues that [nasal] is privative based on Chomsky & Halle's notion of neutral position. The author (1995:152) says:

> "Certain articulatory dimensions, such as the vertical movement of the soft palate, may have a built-in asymmetry between their two extremes: one pole represents the rest position of the relevant organ, relative to which the other pole must count as a deviation. Such articulatory parameters will give rise to the standard analysis in terms of privative features. These features are privative because only one deviation is possible, along the relevant dimension, from the neutral position. This interpretation of the facts allows the distinction between marked and unmarked feature values to be encoded directly into the representations. Context-free markedness in a sound reflects the fact that the sound involves a gesture that deviates from the neutral position. Corresponding to this articulatory deviation there is a linguistic mark, i.e., a feature specification."

Steriade (1995:171, fn. 38), however, notes that:

> "My colleagues in the UCLA Phonetics Laboratory inform me that little, if any, experimental evidence bears on Chomsky and Halle's claim (1968:300) that 'just prior to speaking the subject positions his vocal tract in a certain characteristic manner' which differs 'from the configuration of the vocal tract during quiet breathing', i.e., on the claim that the neutral position is a directly observable articulatory state. This does not invalidate, however, the usefulness of this notion".

If robust experimental evidence is indeed lacking for Chomsky and Halle's proposed neutral position for articulation, one can question, among other things, whether the neutral position for the velum is not subject to parametrization, as will be discussed below.

Steriade assumes Chomsky and Halle's notion of neutral position to support her claim that [-nasal] is universally phonologically unspecified. According to underspecification theories (Archangeli 1988, Steriade 1987, Calabrese 1988, Mester & Itô 1989, among others), only non-redundant feature values are included in underlying specifications. One shows which features are redundant by presenting evidence that these features are phonologically inactive and do not trigger phonological processes. Note that Steriade's position, according to which [nasal] is a privative feature, is inconsistent with the fact that [nasal] is inactive in languages like Apinayé (Salanova 2003), a language that, like Pirahã, has less obstruents than sonorants.

Itô, Master & Padgett (1995) have pointed out that certain problems have threatened the conceptual and empirical basis of underspecification theory, for instance, the (under)specification of the feature [coronal] in English consonants (cf. the coronal syndrome in Kenstowicz 1994). In spite of these problems, these authors agree that "theories of underspecification have brought new depth of explanation to a number of areas of phonological analyses (for example, morpheme structure constraints, harmony systems, assimilation and dissimilation)."

The position that a raised velum is neutral universally is not uncontroversial, however. As seen above, Matisoff (1975:270) attempted to explain the nasality of vowels in contiguity to laryngeal glides by claiming that these phones can be associated to nasality because they are articulated below the velum, allowing the velum to be free to continue in a relaxed position – lowered –, the same position in which it is found in the production of nasal phonemes:

> "Raising the velum requires a certain amount of muscular effort and human beings are notorious for operating according to the "principle of least effort"…it was found that glottal consonants like [h] and [ʔ] seem to require neither a raised nor a lowered velum, but instead allow the velar elevation to be determined by neighboring consonants and vowels (Ohala 1972:1168). This is in sharp contrast both to obstruents (which require a totally raised velum) and to nasal consonants which forbid a totally raised velum".

One can generalize Matisoff's claim by stating that all the [-consonantal] phones are articulated below the velum since they do not require any obstruction of the air in the vocal tract (cf. Halle's 1995 discussion on [-consonantal] segments). If Matisoff is right in affirming that human beings have a tendency to act according to the principle of least effort, we could question whether the neutral position of articulation is really the position of orality for all languages. Perhaps some languages can set the position of nasality as the neutral one since this requires the least effort because it allows the velum to remain in a relaxed position. We believe that such languages are those that have few obstruents (the segments whose articulation, according to Matisoff, requires a totally raised velum). According to this hypothesis, languages that have many obstruents require the velum to be raised so many times that it would be less costly to set the position of orality as neutral. On the other hand, in languages that have few obstruents, the least costly position for the velum prior to articulation is the lowered one.

If this hypothesis were proven to be correct, the problem in relation to Matisoff's explanation pointed out above (section 3) would become a false problem. In our hypothesis, the glides and vowels would function not as a class that causes nasalization but as a class that does not block it. According to this hypothesis, Pirahã nasalized speech is the neutral one and it is blocked by consonantal segments because these segments require the raising of the velum; that is, [+consonantal] segments require that the velum moves out of its relaxed position.

In this paper we reanalyze Pirahã data assuming that it involves orality spreading. In our hypothesis, a lowered velum characterizes the neutral position of the velum in this language, therefore phonological specification is [-nasal] and the nasal feature is implemented by default. Note that a similar proposal is in Anderson (1976) and Kiparsky (1985). These authors argue that in some languages there are processes of local [-nasal]

assimilation (orality spreading). Anderson specifically discusses data of some Brazilian Indian languages (Maxakali, Apinayé, and Kaingang) and proposes preoralization and postoralization of nasal consonants (ma -> $m^{b}a$, am -> $a^{b}m$). Anderson's analysis, however, can be questioned on the basis of Piggott's (1992) proposal for the analysis of nasality in South American Indian languages, which will be presented below.

5. PIGGOTT'S (1992) PROPOSAL

There is an analysis of nasality that can still be considered consistent with the claim that there are no languages that require segments to be phonologically specified as [-nasal], and with the fact that it is inactive in some Brazilian languages. Piggott (1992) argues that languages vary according to two typologies concerning nasality: those that have phonemic contrast between nasal stops and voiced oral stops and those in which these stops do not contrast phonemically. He represents the typological difference by proposing that the feature [nasal] is dependent of the node Soft Palate (SP) in the first case and of a node that he labels Spontaneous Voicing (SV) in the second. The SV node is an alternative label for Chomsky & Halle's (1968) feature [sonorant], and Piggott (1992: 48) defines this node as referring to "a vocal tract configuration in which the vocal cords vibrate in response to the passage of air". In this analysis, in languages where the feature [nasal] is dependent of the SV node, nasality spreads to all and only the segments specified by SV (i.e. sonorants). According to Piggott (1992), the languages discussed by Anderson do not have nasal stops but oral sonorants that are nasalized in contiguity to nasal vowels. That is, under this analysis, Maxakali, Apinayé, and Kaingang have nasalization of oral sonorants rather than oralization of nasal consonants. Piggott claims that nasalization in these languages is triggered either by intrinsically nasal vowels or by a floating nasal feature. Thus, [nasal], under this analysis, is a privative feature, with positive value, that either specifies vowels or is a floating element.

Pirahã does not have a contrast between voiced stops and nasal consonants and therefore it could be classified as a language in which [nasal] is dependent of the SV node. Piggott's analysis, however, fails to explain Pirahã since it predicts the nasalization of oral sonorants (i.e. voiced stops) in contiguity to nasalized vowels, which, as seen before, does not occur in Pirahã. Recall that voiced stops are nasal in the language only in contiguity to silence.

6. OUR ANALYSIS FOR NASALITY AND ORALITY IN PIRAHÃ

In our understanding of the facts, the neutral position of the velum in Pirahã is lowered. So, nasal feature specification in this language is a mirror image of the specification for this feature in better known languages. That is, obstruents are specified as [-nasal]. All the other phonemes are redundantly nasal. If we assume that the neutral position is the one of nasality in Pirahã, we can understand why all segments, except for obstruents, are nasal in Pirahã in fluent speech. This is because obstruents are the only segments underlying specified as oral (i.e. [-nasal]).

Below we repeat the phonemic chart of Pirahã. Note that in our analysis we maintain that voiced stops are real stops in Pirahã.

p	**[-nasal]**	**t**	**[-nasal]**		**k**	**[-nasal]**	**ʔ**
	[-nasal]				**g**	**[-nasal]**	
		s	**[-nasal]**				**h**
i				**a**			**o**

Recall that /b/ and /g/ are oral even when vowels are nasal in their contiguity. Voiced obstruents are nasal in Pirahã only when they occur after pause. We explain this phenomenon by assuming that this is due to a delay in changing the position of the velum. Since the neutral position for Pirahã is lowered, a delay in changing to raised in initial position creates the nasal allophones of stops in this language.

Rodrigues (1986, 2003) discusses nasality and orality in several Brazilian Indian languages. The author notes that nasality is very common in South American languages after silence or pause. According to him (1986:155):

> "Na medida em que se torna conhecido maior número de línguas indígenas da América do Sul, particularmente de sua porção andina, verifica-se que em diversas dessas línguas ocorre a nasalidade de segmentos nas fronteiras de enunciados e de palavras em situação em que a nasalidade só pode ser atribuída à imediata vizinhança com o silêncio que precede ou que segue os enunciados..."

The phenomenon described above occurs in Pirahã as well as in Cayapa, Iranxe, Siriono, Maxacali, and Karaja in South America (Rodrigues 1986).[3]

Rodrigues is the first author that correlates the presence of nasality in the initial position to a delay in raising of the velum (1986:153):

> "O silêncio, enquanto ausência de sons ou ruídos produzidos pelo aparelho fonador, é acusticamente nulo e pode considerar-se articulatoriamente neutro. Entretanto, a postura neutra do aparelho fonador coincide necessariamente, no que respeita ao véu palatino, com a postura própria da nasalidade, isto é, da produção de ressonância nasal: o véu palatino fica abaixado para permitir a respiração normal através da cavidade nasal. Uma consequência desse fato banal é que, quando em qualquer língua vai-se proferir um enunciado que deva iniciar-se por um som não nasal, uma das primeiras articulações a acionar é o levantamento do véu palatino; analogamente, quando se acaba de emitir um enunciado terminado em um som não nasal, tem-se de abaixar o véu palatino."

One could, therefore, following Rodrigues'insight, explain the phenomenon of nasalization in the context of silence by assuming that lowered is the unmarked position of the velum in some languages. Given this assumption, one could say that, in the context of silence, there is a delay or anticipation in changing the position of the velum.[4]

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[3] Note that nasality associated to pause is not an exclusive phenomenon of South America according to Rodrigues (cf. Rodrigues' note 6 about Korean).

[4] In phonetic terms, the reflex of this delay or anticipation is the occurrence of nasal or partially nasalized segments in the context of silence.

The proposal to specify segments as [-nasal] is not new. As should be recalled here, Anderson (1976) argues that some phenomena can be better understood if [-nasal] is accepted as a possible underlying specification, so that it can spread over at least part of other segments as in the so-called pre-and post-nasalized stops. Note that Anderson's proposal opens the possibility of interpreting some facts of Pirahã as long distance orality spreading.

Recall that in Pirahã, although non-obstruents are always nasal in fluent speech, in slow speech vowels are oral in the context of obstruents. We analyze this phenomenon as instances of long-distance orality spreading from left to right. In this analysis, therefore, Pirahã presents an interesting piece of evidence for Anderson's proposal because it shows long distance [-nasal] spreading rather than local spreading as appeared in Anderson's data. Compare below similar words in elicitation contexts that contain an obstruent followed by vowels and a glide followed by vowels. While everything remains nasal in the latter, vowels are oralized in the former.

21. **kaee** 'house
22. **ɦõɛ̃ɛ̃** 'bow'

As mentioned before, in Sandalo (1989) the facts were analyzed as bi-directional nasality spreading triggered by glides. This analysis is problematic for two reasons. First, because there is nothing intrinsic to glides that can trigger nasalization, as discussed before. Second, because it is unnatural for a language to present bi-directional spreading. Languages, in general, set the direction of a given spreading phenomenon; there are languages that show conflicting directionality (cf. Zoll 1998), but in this situation, the language usually establishes different triggering contexts. Under the analysis proposed in this paper we assume that we are dealing in Pirahã with orality spreading and that allows us to establish a clear direction; that is, left to right.

Another fact that corroborates our analysis is the fact that orality spreading occurs only in slow speech. In fluent speech all the segments, except for those phonologically specified as [-nasal], the obstruents are realized as nasal. Our analysis provides a natural explanation for this fact. In fluent speech it is more costly to adjust the position of the velum and change it from the unmarked (lowered) to the marked one (raised) in the context of [-nasal] segments. That explains why all the segments, except for obstruents, which are phonologically [-nasal], are realized as nasal. In slow (careful) speech, on the other hand, such control is possible and obstruents spread their orality to the vowels on the right.

A possible problem for the present analysis that needs to be discussed is the fact that glides never assimilate orality and vowels in contiguity to glides in a same syllable are obligatorily nasal, as can be noticed below, where the /a/ that follows the second /p/ does not assimilate orality:

23. **ʔãpapãỹ** 'head'

In the case of the obligatory nasality of glides in Pirahã, an explanation can be found in Ohala (1983, 1990), according to whom nasalization inhibits frication of glides. It can be, therefore, that Pirahã bans oral glides to avoid neutralization of glides and fricatives. Recall

that glides are the only sonorants of the language. An explanation for the fact that the obstruent does not spread orality to the vowel to its right when such vowel is followed by a glide can be sought in a constraint-based analysis (e.g. Prince & Smolensky 1993). We have to postulate two markedness constraints hierarchically ranked. One that bans nasal segments to the right of obstruents and another that bans oral segments contiguous to glides. The latter is highly ranked.

7. CONSIDERATIONS ABOUT OTHER BRAZILIAN LANGUAGES

We turn now to a comparison between Pirahã and Jê languages, some of which are analyzed in Anderson (1976).

A main difference between Pirahã and Jê languages concerns the phonological status of oral and nasal realizations of certain phonemes. In Pirahã we analyze the phonemes that have an oral allophone ([b] and [g]) and a nasal allophone ([m] and [n]) as voiced stops phonologically specified for the feature [-nasal], based on the fact that they never undergo nasalization in contiguity to nasal vowels; that is, they remain [b] and [g]. In Jê languages and other Brazilian Indian languages like many Tupi languages (cf. Storto 1999), the consonantal phonemes that have oral and nasal allophones are nasalized in contiguity to nasal vowels. The acknowledgement of this phenomenon led to a controversy regarding the phonological interpretation of voiced stops in these latter languages. Analyzing Jê languages, authors like Anderson claimed that there is a set of nasal phonemes that become partially oral in the context of oral vowels. This analysis is assumed by Storto (1999) for Karitiana, a Tupi language. But for other researchers, these languages have a set of oral sonorants that become nasalized in the context of nasal vowels. This analysis was first proposed by Piggott, but it is frequently adopted in the analysis of Brazilian languages (cf. D'Angelis 1998 and Salanova 2001).

Salanova (2003) notes that "considering a [nasal] feature to be present in the noncontinuant sonorants involved in pre- and post-oralization seems counter to the fact that this feature is phonologically inert in the consonants of Apinayé". Our hypothesis deals with the inertness of the feature [nasal] in these languages by proposing that [nasal] is implemented by default. Recall that (section 4), according to underspecification theories (Archangeli 1988, Steriade 1987, Calabrese 1988, Mester & Itô 1989, among others), only non-redundant feature values are included in underlying specifications. One shows which features are redundant by presenting evidence that these features are phonologically inactive and do not trigger phonological processes. As mentioned before, Steriade's position, according to which the positive value of the feature [nasal] is the only possible phonological specification, is inconsistent with the fact that [nasal] is inactive in languages like Apinayé. If nonredundant features are the inert ones, we have to believe that nasality is not in the underlying specification, but it is does not necessarily follow from this assumption that these languages have noncontinuant sonorants that are oral. As discussed before, our hypothesis is that languages that have few obstruents have a lowered velum as the default position. That is, as opposed to languages like English, [-nasal] is privative (is the phonologically specified feature) and nasality is neutral. This is why nasality is phonologically inactive.

According to our analysis, the difference between a language like Pirahã and Jê/Tupi languages comes from the fact that latter languages have vowels specified as [-nasal] and the elements analyzed by Piggott as oral sonorants are actually sonorants without any specification for the nasal feature. In these languages, assimilation of the [-nasal] feature from vowels occurs when a nasal sonorant (i.e. a sonorant that, in our analysis, is nasal by default since it lacks specification for orality) is in contiguity to oral vowels, emerging pre/post nasalized segments. Pirahã does not have vowels specified for the feature [-nasal] (all vowels are unspecified) and therefore the orality and or nasality of vowels is never active in the sense that they never trigger any phonological process.

8. FINAL CONSIDERATIONS

We believe that Anderson's analysis of nasality in Brazilian Indian languages is the correct one. A language like Pirahã differs from the languages analyzed by Anderson in that the latter have short distance orality assimilation whereas Pirahã have long distance orality spreading. Moreover, in Pirahã, orality comes from consonants whereas it comes from vowels and from consonants in Jê languages, since these languages have consonants (fricatives and voiceless stops) and vowels specified for orality.

The Brazilian Indian languages approached here have in common the facts that they have few obstruents, segments whose articulation requires a totally raised velum. According to the hypothesis of this paper, languages that have many obstruents require the velum to be raised so many times that it would be less costly to set the position of orality as neutral. On the other hand, in languages that have few obstruents, the least costly position for the velum prior to articulation is the lowered one. In these languages, phonology specifies [-nasal] segments since the neutral/unmarked phonologically are the segments that allow the velum to remain lowered. These languages, as opposed to languages that set the oral position as neutral, have orality, i.e. [-nasal], spreading.

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